

What is claimed is:

1. An audience survey system, comprising:

(A) a plurality of portable monitoring units that are assigned to users that are members of an audience panel, wherein each portable monitoring unit records information representative of free field audio signals received by the portable monitoring unit, and the information representative of the free field audio signals includes information representing content of free field audio signals and time stamp information indicating when the free field audio signals were received by the portable monitoring unit;

(B) a central broadcast collection facility that records information representative of audio signals transmitted from a plurality of sources, wherein for each audio signal the information recorded by the central broadcast collection facility includes information representing content of the audio signal, time stamp information indicating when the audio signal was received by the central broadcast collection facility, and source information indicating a source that transmitted the audio signal; and

(C) a computer that identifies the source selected by each user of a portable monitoring unit during each of a plurality of different time periods in accordance with the information recorded by the portable monitoring units and the information recorded by the central broadcast collection facility.

2. The system of claim 1, wherein each portable monitoring unit periodically records the information representative of the free field audio signals received by the portable monitoring unit.

3. The system of claim 2, wherein the central broadcast collection facility continuously records the information representative of audio signals broadcast from the plurality of sources.

4. The system of claim 3, wherein the computer is coupled to the central broadcast  
5 collection facility, said system further comprising:

(D) a plurality of docking stations each of which periodically downloads the information recorded by a portable monitoring unit to the computer.

5. The system of claim 4, wherein each of the docking stations includes a modem for communicating with the computer, and a charger that charges a battery in a portable monitoring  
10 unit when the portable monitoring unit is positioned in the docking station.

6. The system of claim 1, wherein each portable monitoring unit includes a microphone that receives free field audio signals associated with a source selected by the user of the portable monitoring unit.

7. The system of claim 1, wherein each portable monitoring unit is worn or carried  
15 by a user.

8. The system of claim 1, wherein the information representative of the free field audio signals recorded by each portable monitoring unit includes a digitally compressed version of content associated with free field audio signals received by the portable monitoring unit.

9. The system of claim 8, wherein the information recorded by the central broadcast collection facility includes a digitally compressed version of content associated with the audio signals received by the central broadcast collection facility.

10. The method of claim 1, wherein the central broadcast collection facility and the computer that identifies the source selected by each user of a portable monitoring unit during each of a plurality of different time periods are implemented using a common host computer.

11. A method for performing an audience survey, comprising the steps of:

(A) providing a plurality of portable monitoring units to users that are members of an audience panel, wherein each portable monitoring unit records information representative of free field audio signals received by the portable monitoring unit, and the information representative of the free field audio signals includes information representing content of free field audio signals and time stamp information indicating when the free field audio signals were received by the portable monitoring unit;

(B) recording, at a central broadcast collection facility, information representative of audio signals broadcast from a plurality of sources, wherein for each audio signal the information recorded by the central broadcast collection facility includes information representing content of the audio signal, time stamp information indicating when the audio signal was received by the central broadcast collection facility, and source information indicating a source that transmitted the audio signal; and

(C) identifying the source selected by each user of a portable monitoring unit during each of a plurality of different time periods in accordance with the information recorded by the

portable monitoring units and the information recorded by the central broadcast collection facility.

12. A method for forming compressed audio signals, comprising the steps of:

(A) acquiring an audio signal from a microphone or a broadcast receiver;

5 (B) for each of a plurality of time periods, measuring a power level associated with the acquired audio signal in each of at least three frequency bands;

(C) constructing time domain audio feature waveforms from the results of step (B), wherein each time domain audio feature waveform represents power levels measured in one of the at least three frequency bands over the plurality of time periods; and

10 (D) forming logarithmically compressed audio signals representative of the acquired audio signal by applying mu-law compression to the results of step (C).

13. The method of claim 12, further comprising:

15 (E) constructing packets of feature waveforms from the results of step (D), wherein each packet of feature waveforms is representative of several contiguous seconds of the acquired audio signal.

14. The method of claim 13, wherein step (E) further comprises applying a time marker to each packet representative of a time when the audio signal was acquired from the microphone or the broadcast receiver.

15. The method of claim 12, further comprising:

(E) constructing continuous feature waveforms from the results of step (D), and storing the continuous feature waveforms in a computer.

16. The method of claim 15, wherein step (E) further comprises periodically applying time markers to segments of the continuous feature waveforms, each time marker being  
5 representative of a time when the audio signal was acquired from the microphone or the broadcast receiver.

17. The method of claim 16, further comprising the step of:

(F) periodically deleting from the computer segments of the continuous feature waveforms having time markers that are older than a specified limit.

18. A method for synchronizing time between a portable data collection unit and a  
10 host computer that receives downloaded information from the portable data collection unit, comprising the steps of:

(A) marking information recorded in the portable data collection unit with time markers that are obtained from an output of a first counter in the portable data collection unit;

15 (B) downloading the time marked information from the portable data collection unit to the host computer at a time T and storing, in the host computer, an output of the first counter and an output of a second counter in the host computer at the time T; and

(C) adjusting the time markers in the time marked information in accordance with the output of the first counter at time T, the output of the second counter at time T, and any  
20 frequency difference between a frequency of the first counter and a frequency of the second

counter, thereby synchronizing the time markers in the time marked information to the second counter in the host computer.

19. The method of claim 18, wherein the frequency difference between the frequency of the first counter and the frequency of the second counter is zero.

5 20. The method of claim 18, wherein the output of the second counter corresponds to an absolute system time.

21. The method of claim 18, wherein steps (B) and (C) comprise the following steps:

22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 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2633 2634 2635 2636 2637 2638 2639 2640 2641 2642 2643 2644 2645 2646 2647 2648 2649 2650 2651 2652 2653 2654 2655 2656 2657 2

(ii) determining a second elapsed time value by comparing the output of the second counter at the first time T1 with the output of the second counter at the second time T2;

(iii) determining a scale factor (Scl) in accordance with the first elapsed time value and the second elapsed time value; and

5 (iv) adjusting each time marker ( $T_p$ ) in the time marked information to a time value ( $T_c$ ) that is synchronized with the second counter in the host computer in accordance with the following equation:

$$T_c = (T_p + \text{Off}) * \text{Scl}$$

where Off corresponds to an offset between the first counter and the second counter.

10 23. The method of claim 22, wherein Off has a value corresponding to a difference between the output of the second counter at the first time T1 and the output of the first counter at the first time T1.

24. An apparatus for synchronizing time between a portable data collection unit and a host computer that receives downloaded information from the portable data collection unit,  
15 wherein information is recorded in the portable data collection unit with time markers that are obtained from an output of a first counter in the portable data collection unit, comprising:

a host computer that downloads the time marked information from the portable data collection unit to the host computer at a time T, stores an output of the first counter and an output of a second counter in the host computer at the time T, and adjusts the time markers in the time  
20 marked information in accordance with the output of the first counter at time T, the output of the

second counter at time T, and any frequency difference between a frequency of the first counter and a frequency of the second counter, thereby synchronizing the time markers in the time marked information to the second counter in the host computer.

25. A portable data collection unit that operates in either a sleep mode or an active mode, comprising:

(A) a microphone that receives free field audio signals that are audible to a user proximate the portable data collection unit;

(B) a processor that periodically places the portable data collection unit into the active mode for a predetermined period of time after which the controller places the portable data collection unit into the sleep mode;

wherein the processor is coupled to an output of the microphone and compares the output of the microphone to a threshold when the portable data collection unit is in the active mode; and

wherein the processor stores data representative of the free field signals only during periods when the portable data collection unit is in the active mode and the output of the microphone exceeds the threshold.

26. A system for periodically transferring information from portable monitoring units to a central computer, comprising:

(A) a plurality of portable monitoring units that are assigned to users, wherein each portable monitoring unit records information representative of free field audio signals received by the portable monitoring unit;



(B) a plurality of docking stations each of which receives a portable monitoring unit when the portable monitoring unit is not being worn by one of the users, wherein each of the docking stations includes a modem; and

5 (C) a central information collection facility that periodically places a call to the modem in each of the docking stations, wherein the central information collection facility downloads information stored in a given portable monitoring unit if the given portable monitoring unit is positioned in a docking station when the central information collection facility places the call to the docking station.

10 27. A method for correlating a first packet of feature waveforms from an unknown source with a second packet of feature waveforms from a known source in order to associate a known source with the first packet of feature waveforms, comprising the steps of:

15 (A) determining at least first, second and third correlation values ( $cv_1$ ,  $cv_2$ ,  $cv_3$ ) by correlating features from the first and second packets, wherein the first correlation value ( $cv_1$ ) is determined by correlating features associated with a first frequency band from the first and second packets, the second correlation value ( $cv_2$ ) is determined by correlating features associated with a second frequency band from the first and second packets, and the third correlation value ( $cv_3$ ) is determined by correlating features associated with a third frequency band from the first and second packets;

20 (B) computing a first weighting value in accordance with the features from the second packet associated with the first frequency band, a second weighting value in accordance with the

features from the second packet associated with the second frequency band, and a third weighting value in accordance with the features from second packet associated with the third frequency band;

(C) computing a weighted Euclidean distance value ( $D_w$ ) representative of differences between the first and second packets from the first, second and third correlation values and the first, second and third weighting values; and

(D) associating the first frequency packet with the known source in accordance with the weighted Euclidean distance value ( $D_w$ ).

28. The method of claim 27, wherein the first weighting value corresponds to a standard deviation ( $std_1$ ) of the features from the second packet associated with the first frequency band, the second weighting value corresponds to a standard deviation ( $std_2$ ) of the features from the second packet associated with the second frequency band, and the third weighting value corresponds to a standard deviation ( $std_3$ ) of the features from the second packet associated with the third frequency band.

29. The method of claim 28, wherein the weighted Euclidean distance value ( $D_w$ ) is determined in accordance with the following equation:

$$D_w = [((std_1)*(1-cv_1))^2 + ((std_2)*(1-cv_2))^2 + ((std_3)*(1-cv_3))^2]^{1/2} / [(std_1)^2 + (std_2)^2 + (std_3)^2]^{1/2}$$

30. The method of claim 27, wherein step (D) comprises:

(D) associating the first frequency packet with the known source if the weighted Euclidean distance value ( $D_w$ ) is less than a threshold.

31. A method for correlating a packet of feature waveforms from an unknown source with a packet of feature waveforms from a known source in order to associate a known source with the packet of feature waveforms from the unknown source, comprising the steps of:

(A) determining at least first, second and third correlation values by correlating features from first and second packets, wherein the first correlation value is determined by correlating features associated with a first frequency band from the first and second packets, the second correlation value is determined by correlating features associated with a second frequency band from the first and second packets, and the third correlation value is determined by correlating features associated with a third frequency band from the first and second packets;

(B) computing a Euclidean distance value ( $D(n-1)$ ) representative of differences between the first and second packets from the first, second and third correlation values;

(C) determining at least fourth, fifth and sixth correlation values by correlating features from third and fourth packets, wherein the fourth correlation value is determined by correlating features associated with the first frequency band from the third and fourth packets, the fifth correlation value is determined by correlating features associated with the second frequency band from the third and fourth packets, and the sixth correlation value is determined by correlating features associated with the third frequency band from the third and fourth packets;

(D) computing a Euclidean distance value ( $D(n)$ ) representative of differences between the third and fourth packets from the fourth, fifth and sixth correlation values;

(E) updating the Euclidean distance value ( $D(n)$ ) using the Euclidean distance value ( $D(n-1)$ ); and

(F) associating the third packet with the known source in accordance with the updated Euclidean distance value ( $D(n)$ ).

5           32. The method of claim 31, wherein the second and fourth packets are known a priori to represent signals broadcast from the known source.

33. The method of claim 32, wherein the third packet is positioned immediately after the first packet in a sequence of packets of feature waveforms.

34. The method of claim 33, wherein the fourth packet is positioned immediately  
10 after the second packet in a sequence of packets of feature waveforms.

35. The method of claim 34, wherein the updated the Euclidean distance value ( $D(n)$ ) is determined in step (E) in accordance with the following equation:

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$$D(n) = k * D(n-1) + (1-k) * D(n)$$

where  $k$  is a coefficient that is less than 1.

15           36. The method of claim 31, wherein step (F) comprises:

(F) associating the third frequency packet with the known source if the updated Euclidean distance value ( $D(n)$ ) is less than a threshold.